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INSPECTION GUIDE FOR REINFORCED CONCRETE VESSELS

Volume 1 INSPECTION GUIDE

A. E. Fiorato

L. S. Johal

Construction Technology Laboratories

A Division of the Portland Cement Association

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16. Abstract

This guide provides a check list for use by U.S. Coast Guard Marine Inspectors in the inspection of reinforced concrete vessels. It provides itemized requirements to insure quality of newly constructed vessels and proper maintenance of in-service vessels. Topics covered include materials, batching and mixing, inspection before concreting, inspection during concreting, inspection after concreting, testing hardened concrete, in-service inspection, and repairs.

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U.S. COAST GUARD

INSPECTION GUIDE FOR

REINFORCED CONCRETE VESSELS

1. INTRODUCTION

This Guide provides U.S. Coast Guard Marine Inspectors with a detailed check list of items to be considered for quality assurance of construction of reinforced concrete vessels and for in-service inspection of vessels. It is recognized that, within the regulatory role of the U.S. Coast Guard, the Marine Inspector does not serve to perform quality control tests for the vessel owner or contractor. However, it is necessary for the Inspector to monitor construction operations and to participate in in-service inspections so that he may determine if the condition of the vessel is satisfactory to insure safety of life and property at sea.

It is anticipated that general inspection and monitoring operations for reinforced concrete vessels will be similar to those for steel vessels. However, inspection of concrete vessel construction may require a greater level of effort. This is because concrete is essentially "manufactured" on site.

This guide is supplemented by a separate document entitled "Commentary on Inspection Guide for Reinforced Concrete Vessels," that provides background information for topics covered. It is assumed that Inspectors using the guide have knowledge of the fundamentals of concrete technology and reinforced and prestressed concrete.

Material in the guide is based on current practice for concrete in marine environments. The following publications have served as a basis for much of the material:

(a) ACI Committee 357, "Guide for the Design and Construction of Fixed Offshore Concrete Structures," American Concrete Institute, 1978.

(b) ACI Committee 318, "Building Code Requirements for Reinforced Concrete (ACI 318-77)," American Concrete Institute, 1977.

(c) "Rules for the Design, Construction, and Inspection of Offshore Structures," Det Norske Veritas, 1977.

(d) "Guidelines for the Design, Construction, and Classification of Floating Concrete Structures," Det Norske Veritas, 1978.

(e) "Recommendations for the Design and Construction of Concrete Sea Structures," Federation Internationale de la Precontrainte, Third Edition, 1977.

(f) ACI Committee 301, "Specifications for Structural Concrete for Buildings," American Concrete Institute, 1975.

(g) "Inspection, Maintenance and Repair of Concrete Offshore Structures," Cement and Concrete Association, London, 1974.

Data in these publications were supplemented with information from references listed in Appendixes to this Guide.

1.1 Format of Guide

The Guide is presented as a detailed checklist. Primary objective of the list is to insure that items critical to quality assurance are monitored by U.S. Coast Guard inspection. Data in the checklist are not intended to supercede construction specifications and drawings. These documents should be closely examined prior to start of construction.

The frequency of U.S. Coast Guard inspection will depend on a number of factors including size and complexity of the project, experience and performance record of the contractor, experience and performance record of the testing laboratory, and experience of the Marine Inspector. The level of inspection effort will vary at different stages of construction. After

verification of test procedures, documentation, and flow of reports, the Coast Guard Marine Inspector may choose to monitor daily test reports, and only spot-check field operations. Although the inspector may not verify all items on the checklist, he should be certain that they have been considered in the construction process.

1.2 Use of the Guide

The Inspector's initials and the date of inspection should be entered after an item on the list has been verified. If the item is not applicable, the letters "NA" should be entered. If no entries appear after an item, it is assumed that the Inspector is not satisfied with the inspection results and that corrective measures are being taken. At the Inspector's option, corrective measures to be taken may be noted in the guide. Reinspection of an item may be indicated by entering initials and the new date in a different color.

Items marked with an asterisk (*) generally require inspection on a regular basis. Frequency of inspection will be based on specific requirements of each project.

Numbers of Sections 4 through 11 correspond to companion sections in the "Commentary on Inspection Guide for Reinforced Concrete Vessels."

2. VESSEL DATA

Vessel Name: _____

Official No.: _____

Type of Vessel: _____

Vessel Owner: _____

Shipyard: _____

Testing Laboratory(ies): _____

_____

_____

3. PRELIMINARY INSPECTION

CHECK LIST	INITIALS	DATE	NOTES
1. Have design and drawings been approved by USCG Merchant Marine Technical Branch?	____	____	
2. Have plans and specifications been reviewed by inspector prior to start of construction?	____	____	
3. Has a preconstruction conference been held with USCG, Owner, Classification Society, Contractor, Testing Laboratory, and other interested parties to review construction specifications and to coordinate inspection operations?	____	____	
4. Have representatives been assigned for coordination of inspection between USCG, Owner, Classification Society, Contractor, Test Laboratory, and other interested parties?	____	____	
5. Have provisions been made for flow of records and reports?	____	____	
6. Does the Testing Laboratory(ies) meet requirements of ASTM E329?	____	____	
7. Has the Testing Laboratory(ies) been inspected by the Materials Reference Laboratory?	____	____	

4. MATERIALS

4.1 Cement

CHECK LIST	INITIALS	DATE	NOTES
1. Does portland cement conform to ASTM C150 Type I, II, or III; or ASTM C595 Blended Hydraulic Cements?	____	____	
2. Are certified copies of mill test reports for cement included with each shipment as follows:			
(a) Chemical Analysis (ASTM C114)	____	____	
(b) Fineness by Turbidimeter (ASTM C115) or Fineness by Air Permeability (ASTM C204)	____	____	
(c) Autoclave Expansion (ASTM C151)	____	____	
(d) Time of Setting by Vicat Needle (ASTM C191) or Time of Setting by Gillmore Needles (ASTM C266)	____	____	
(e) Air Content of Mortar (ASTM C185)	____	____	
(f) Compressive Strength (ASTM C109)	____	____	
(g) False Set (ASTM C451) - Optional	____	____	
(h) Heat of Hydration (ASTM C186) - Optional	____	____	
3. Is tricalcium aluminate content (C_3A) within limits stated in construction specification?	____	____	
4. Is incoming cement sampled and tested to verify supplier's certifications?	____	____	
5. In addition, are tests ASTM C109 and ASTM C191 repeated monthly to check quality of cement in storage?	____	____	
6. If cement is packaged, is it marked showing type, brand, date of receipt, and manufacturer's name?	____	____	

4. MATERIALS

4.1 Cement (Continued)

CHECK LIST	INITIALS	DATE	NOTES
7. Is packaged cement protected from weather during shipment and storage?	____	____	
8. Is packaged cement used in the chronological order that it was delivered?	____	____	
9. Is bulk cement stored in weather-tight bins or silos?	____	____	
10. Are controls adequate to identify bulk cement?	____	____	
11. Are there individuals responsible for receiving, inspecting, storing, and handling cement?	____	____	
12. Are records available on all of the above items?	____	____	

4. MATERIALS

4.2 Aggregates

CHECK LIST	INITIALS	DATE	NOTES
1. Do aggregates conform to ASTM C33 or C330?	____	____	
2. Is there more than one (1) location from which aggregate is obtained and are tests made from each?	____	____	
3. Have the following tests been performed on the aggregate?	____	____	
(a) Grading and Fineness Modulus (ASTM C136 or ASTM C330)	____	____	
(b) Amount of Material Finer Than No. 200 Sieve (ASTM C117)	____	____	
(c) Organic Impurities (ASTM C40)	____	____	
(d) Mortar Strength Test (ASTM C87)	____	____	
(e) Soundness (ASTM C88)	____	____	
(f) Friable Particles (ASTM C142)	____	____	
(g) Coal and Lignite (ASTM C123)	____	____	
(h) Abrasion of Coarse Aggregate (ASTM C131 or ASTM C535)	____	____	
(i) Specific Gravity and Absorption - Coarse Aggregate (ASTM C127)	____	____	
(j) Specific Gravity and Absorption - Fine Aggregate (ASTM C128)	____	____	
(k) Bulk Unit Weight (ASTM C29)	____	____	
(l) Water Soluble Chlorides (ASTM D1411)	____	____	
(m) Flat or Elongated Particles (ASTM C125 and ASTM D3398 or Corps of Engineers Spec. CRD-C119-53)	____	____	

4.2 Aggregates (Continued)

CHECK LIST	INITIALS	DATE	NOTES
(n) Soft Particles (ASTM C235)	____	____	
(o) Compressive and Flexural Strength in Concrete (ASTM C39 and ASTM C78).	____	____	
(p) Freezing and Thawing Resistance (ASTM C682 or C666)	____	____	
(q) Reactive Aggregates (ASTM C227, ASTM C289, ASTM C342, and ASTM C586)	____	____	
4. Are incoming aggregates sampled and tested to verify supplier's certification and are tests properly documented?	____	____	
5. Do procedures for unloading aggregates prevent harmful segregation and breakage?	____	____	
6. Do procedures for stockpiling prevent harmful segration and breakage?	____	____	
7. Is aggregate stored in a manner to prevent contamination and inclusion of foreign material in the concrete, and to insure that aggregates are not intermingled?	____	____	
8. Is free water in aggregates allowed to drain prior to their use?	____	____	
9. Do procedures for prewetting lightweight aggregate provide thorough and uniform distribution of water?	____	____	
10. If marine aggregates are used, are they washed with fresh water so that chloride and sulfate contents are within limits of construction specifications?	____	____	

4. MATERIALS

4.2 Aggregates (Continued)

CHECK LIST	INITIALS	DATE	NOTES
11. Does maximum aggregate size conform to construction specifications?	_____	_____	
12. Are records available for all above items?	_____	_____	

4. MATERIALS

4.3 Mixing Water

CHECK LIST	INITIALS	DATE	NOTES
1. Is water supply adequate and supplied at pressures sufficiently uniform to insure accurate measurement?	____	____	
2. Is water potable?	____	____	
3. Have the following tests been performed on the water (including ice) by the Testing Laboratory?	____	____	
(a) Chloride Content (ASTM D512)	____	____	
(b) Sulfate Content (ASTM D516)	____	____	
4. Are chloride and sulfate contents within limits of construction specifications?	____	____	
5. Are records available on all above items?	____	____	

4. MATERIALS

4.4 Admixtures

CHECK LIST	INITIALS	DATE	NOTES
1. Is handling and storage system adequate to prevent inadvertent mixing or contamination of admixtures?	____	____	
2. Are admixture containers clearly labeled by type, proprietary name, and amount?	____	____	
3. Are liquid admixtures protected to prevent freezing?	____	____	
4. Is agitation provided for liquid admixtures that are not stable solutions?	____	____	
5. Are all admixtures being used as specified in construction specifications or as approved by the design office?	____	____	
6. Does air-entraining admixture conform to ASTM C260?	____	____	
7. Do water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and retarding admixtures, and water-reducing and accelerating admixtures conform to ASTM C494?	____	____	
8 If pozzolans are used, do they conform to ASTM C618 and have they been tested for sulfate resistance and corrosion when used in concrete with the selected type of cement?	____	____	
9. If two or more admixtures are used, is their compatibility documented?	____	____	
10. Does use of admixtures containing chloride ions result in excess chloride content as established by construction specifications?	____	____	
11. Are records available on all above items?	____	____	

4.5 Reinforcing and Prestressing Steel

	CHECK LIST	INITIALS	DATE	NOTES
1.	Is deformed steel being used for all reinforcement except spirals or prestressing tendons?	____	____	
2.	Do deformed reinforcing bars conform to ASTM A615, A616, A617, or A706?	____	____	
3.	Are certified test reports of heat number, chemical analysis, and mechanical properties submitted for each heat and size of bar?	____	____	
4.	Does yield strength of deformed reinforcement conform to that determined by tests on full size bars?	____	____	
5.	Do bend test requirements for deformed reinforcement conform to ACI 318-77, Section 3.5.3.2?	____	____	
6.	Is weldable reinforcing steel being used in the splash zone, unless otherwise indicated in the construction specifications?	____	____	
7.	Do epoxy coated or galvanized reinforcing bars meet requirements of construction specifications?	____	____	
8.	Do bar and rod mats for concrete reinforcement conform to ASTM A184?	____	____	
9.	Does smooth wire for spiral reinforcement conform to ASTM A82?	____	____	
10.	Does deformed wire for concrete reinforcement conform to ASTM A496?	____	____	
11.	Does welded smooth wire fabric for concrete reinforcement conform to ASTM A185?	____	____	
12.	Does welded deformed wire fabric for concrete reinforcement conform to ASTM A497?	____	____	

4.5 Reinforcing and Prestressing Steel (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
13.	For bars, wire, or wire fabric with a specified yield strength exceeding 60,000 psi, is the yield strength defined at a stress corresponding to a strain of 0.35 percent?	____	____	
14.	Are certified test reports of chemical analysis and mechanical properties submitted for deformed wire, wire fabric, and smooth wire reinforcement?	____	____	
15.	Are shipments of reinforcing materials identified as to heat number, manufacturer, size, type, and grade?	____	____	
16.	Are reinforcing materials segregated and stored according to type, grade, and size?	____	____	
17.	Does the Test Laboratory perform sampling to verify supplier's certifications?	____	____	
18.	Is rejected reinforcement tagged and separated from acceptable reinforcement?	____	____	
19.	Do prestressing wires, strands, and bars conform to ASTM A421, ASTM A416, and ASTM A722, respectively?	____	____	
20.	If low-relaxation wire or strand is specified, are tests in accordance with ASTM E328?	____	____	
21.	Do anchorage components for prestressing systems conform to dimensions, finish, alignment, and tolerances given in Construction Specifications?	____	____	

4. MATERIALS

4.5 Reinforcing and Prestressing Steel (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
22.	Are anchorages and couplings capable of developing at least 95% of the minimum specified ultimate tensile strength of the prestressing steel in the unbonded condition without exceeding anticipated set?	____	____	
23.	Have prestressing tendon assemblies been tested under static and dynamic conditions in accordance with PTI Guide Specifications unless otherwise stated in the construction specifications?	____	____	
24.	Are certified test reports on prestressing materials and tendon assemblies available?	____	____	
25.	Are prestressing materials and tendon assemblies shipped and stored in weathertight enclosures to insure protection against corrosion?	____	____	
26.	Are welding, flame cutting or similar operations carried out far enough away from stored prestressing tendons to insure that temperature of the tendons is not raised and that tendons are not splashed with weld material?	____	____	
27.	Are prestressing tendons kept clean, and free from grease, insoluble oil, deposits of salt, or any other material likely to affect bond or durability?	____	____	
28.	Are protective wrappings or coatings for tendons chemically neutral and designed to prevent electro-corrosive attack?	____	____	
29.	Are records available for all above items?	____	____	

4.6 Post-Tensioning Ducts

CHECK LIST	INITIALS	DATE	NOTES
1. Are post-tensioning ducts semi-rigid, mortar-tight, and water-tight with at least 1 mm wall thickness?	____	____	
2. Are ducts nonreactive with concrete, tendons, or filler material?	____	____	
3. Are ferrous ducts or galvanized metal ducts passivated by chromate wash?	____	____	
4. Have plastic ducts been rejected unless specified in construction specifications?	____	____	
5. Do ducts for single wire, strand, or bar tendons have an inside diameter at least 1/4 in. larger than the nominal diameter of the tendon?	____	____	
6. Do ducts for multiple wire, strand, or bar tendons have an inside cross-sectional area at least twice the nominal net area of the enclosed tendon?	____	____	
7. Are bell and spigot joints used with saw-cut ends free of burrs and dents?	____	____	
8. Are ducts provided with openings at both ends for grout injection?	____	____	
9. Are ducts stored clear of the ground and protected from weather?	____	____	

4. MATERIALS

4.7 Grout for Bonded Tendons

CHECK LIST	INITIALS	DATE	NOTES
1. Does cement for grout conform to ASTM C150 Type I, II, or III?	____	____	
2. Does cement satisfy limits for tricalcium aluminate content specified in construction specifications?	____	____	
3. Does mixing water satisfy limits on chloride and sulfate content specified in construction specifications?	____	____	
4. Is mixing water potable?	____	____	
5. Does sand, if used, conform to ASTM C144 (with exception of gradation which may be modified as necessary for workability)?	____	____	
6. Have admixtures for grout been tested for possible injurious effects on grout, steel, or concrete (chlorides, for example)?	____	____	
7. Have admixtures been screened to insure that calcium chloride is not used?	____	____	
8. Have mix proportions for grout been established by test results on fresh and hardened material or, alternatively, on the basis of prior documented experience?	____	____	
9. Are total chlorides in grout limited to those stated in construction specifications?	____	____	
10. Does water-cement ratio of the grout exceed 0.45 by weight?	____	____	
11. Is free volumetric expansion of grout limited to 10%?	____	____	

4.7 Grout for Bonded Tendons (Continued)

CHECK LIST	INITIALS	DATE	NOTES
12. Is bleeding of grout, tested in accordance with PTI Guide Specifications, limited to 2% by volume three hours after mixing, and is the separated water reabsorbed after 24 hours?			

4. MATERIALS

4.8 Inserts and Embedments

CHECK LIST	INITIALS	DATE	NOTES
1. Is use of aluminum inserts and embedments prohibited?			
2. Are reinforcing bars used for anchorage of embedment plates made of weldable steel?	____	____	
3. Are reinforcing bars attached to anchorage plates by full penetration welds made in accordance with AWS D12.1?	____	____	

4. MATERIALS

4.9 Concrete

	CHECK LIST	INITIALS	DATE	NOTES
*1.	Does the maximum water-cement ratio of the mix conform to the construction specifications?	____	____	
*2.	Does the minimum cement content conform to the construction specifications?	____	____	
*3.	Does the minimum design compressive strength conform to the construction specifications?	____	____	
*4.	Has the minimum design compressive strength been increased, and are aggregates sufficiently hard, in areas where severe abrasion is anticipated?	____	____	
*5.	Does amount of air entrainment conform to the construction specifications?	____	____	
*6.	Does total chloride content of concrete conform to the construction specifications?	____	____	
7.	Have measures been established to minimize cracking in thin sections and to prevent excessive thermal stresses in mass concrete where high cement contents (in excess of approximately 700 lbs per cubic yard of concrete) are used?	____	____	

5. BATCHING AND MIXING CONCRETE

CHECK LIST	INITIALS	DATE	NOTES
1. Does the ready mix concrete production facility meet certification requirements established by NRMCA?	____	____	
2. Does the accuracy of weighing scales conform to ASTM C94 unless otherwise stated in the construction specifications?	____	____	
3. Are scales arranged so that the plant operator can observe all dials or indicators during the operation?	____	____	
4. Are cement, aggregate, and water weight recorders functioning properly?	____	____	
5. Is equipment for automatic measuring of moisture content of aggregate functioning properly?	____	____	
6. Is bulk cement weighed on a separate scale in a separate weigh batcher?	____	____	
7. Are batching controls inter-locked to prevent starting of a new batching cycle before all batchers are completely empty?	____	____	
8. Is batching equipment capable of meeting accuracy limits stated in ASTM C94?	____	____	
9. Is there leakage when valves are closed in the delivery water system?	____	____	
10. Are filling and discharge valves interlocked to prevent discharging before completion of filling operation?	____	____	
11. Are scale calibration records available?	____	____	
12. Are scale calibrations repeated at least quarterly unless otherwise stated in construction specifications?	____	____	

5. BATCHING AND MIXING CONCRETE (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
13.	If separate dispensers are not used for liquid admixtures, are provisions made for cleaning dispensers when admixtures are changed?	____	____	
14.	Is admixture dispenser system free of leaks and properly valved to prevent backflow or siphoning?	____	____	
15.	Do mixer and agitator trucks carry TMMB rating plate?	____	____	
16.	Do concrete delivery trucks conform to ASTM C94?	____	____	
17.	Are all trucks equipped with accurate revolution counters?	____	____	
18.	Are mixers operated at manufacturer's designated drum speed?	____	____	
19.	When truck mixing, do number of revolutions conform to ASTM C94 or the construction specifications?	____	____	
20.	Are mixer drums free of hardened concrete?	____	____	
21.	When a mixer produces unsatisfactory results, is its use discontinued?	____	____	
22.	When ice is used to cool mixing water, is it finely crushed, shaved or chipped?	____	____	
23.	Is ice completely melted at end of mixing?	____	____	
24.	In cold weather, are provisions made for heating water and/or aggregates to insure specified temperature at placement of concrete?	____	____	

5. BATCHING AND MIXING CONCRETE (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
25.	In cold weather, are procedures established to insure that cement is not mixed with water, or with mixtures of water and aggregates, having a temperature greater than 100F?	____	____	
26.	In cold weather, are there adequate provisions to prevent materials containing frozen clumps, ice or snow from entering batching equipment?	____	____	
27.	Are precautions taken to insure that deleterious salts or chemicals are not used to lower the freezing point of water?	____	____	
28.	Are batching and mixing procedures for lightweight aggregate concrete in accordance with the construction specifications?	____	____	
*29.	Do delivery tickets contain following information:			
	(a) Name of ready-mixed concrete company?	____	____	
	(b) Plant designation where batched?	____	____	
	(c) Ticket serial number?	____	____	
	(d) Truck number or designation?	____	____	
	(e) Name of contractor or purchaser?	____	____	
	(f) Job designation?	____	____	
	(g) Concrete designation?	____	____	
	(h) Amount of concrete (cubic yards)?	____	____	
	(i) Date?	____	____	
	(j) Time batch was loaded?	____	____	

5. BATCHING AND MIXING CONCRETE (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
(k)	Extra water added at request of receiver and his signature?	____	____	
(l)	Type and name of admixtures and amount batched?	____	____	
*30.	Are delivery tickets properly filled in and signed?	____	____	
*31.	Do delivery tickets accompany each load of concrete?	____	____	
*32.	Are delivery tickets completed and filed at point of receipt?	____	____	

6. INSPECTION BEFORE CONCRETING

6.1 Reinforcement

	CHECK LIST	INITIALS	DATE	NOTES
*1.	At time of concrete placement, is reinforcement free of mud, loose rust, grease, oil, deposits of salts, ice, snow, or other materials that may adversely affect bond or durability?	____	____	
*2.	Do reinforcing bars with mill-scale or rust meet minimum dimensions specified in ASTM A615, A616, A617, or A706 as applicable (based on hand wire brushed test specimen)?	____	____	
*3.	Where standard hooks for reinforcing bars are specified, do they conform to ACI 318?	____	____	
*4.	Do bend diameters of reinforcement conform to ACI 318, unless otherwise stated in the construction specifications?	____	____	
5.	Is reinforcement fabricated prior to placement cold bent?	____	____	
6.	Are provisions made to insure that field bending of reinforcement partially embedded in concrete is only done after approval by the project engineer, unless such bends are shown on construction drawings?	____	____	
7.	Do welds of reinforcing bars conform to AWS D12.1?	____	____	
8.	Are welders qualified in accordance with AWS D12.1?	____	____	
*9.	Are records of welding procedures and weld qualifications maintained?	____	____	
*10.	Are procedures established to insure that tack welds are not used on reinforcement unless authorized by the project engineer?	____	____	

6. INSPECTION BEFORE CONCRETING

6.1 Reinforcement (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
11.	Do welding procedures prohibit grounding to reinforcement?	____	____	
12.	Is reinforcement protected against weld splatter and arcs due to strikes or current drainage?	____	____	
*13.	Are completed welds visually inspected for cracks and size?	____	____	
*14.	Are defective welds repaired or replaced?	____	____	
*15.	Are reinforcing bar splices located in accordance with the construction specifications?	____	____	
*16.	Is length of lap splices of reinforcing bars and welded wire fabric in accordance with the construction specifications?	____	____	
*17.	Are anchorage lengths of embedded reinforcement in accordance with the construction specifications?	____	____	
*18.	Do mechanical splices of reinforcement conform to the construction specifications?	____	____	
19.	Have tensile tests conforming to ASTM A370 been conducted on samples of bars mechanically spliced to insure that strength of the bar can be developed and that elongation across the splice does not exceed specified limits?	____	____	
*20.	Is reinforcement located and securely supported to insure that specified concrete cover will be obtained?	____	____	
*21.	Is reinforcement placed within tolerances specified in ACI 318 unless otherwise stated in the construction specifications?	____	____	

6. INSPECTION BEFORE CONCRETING

6.1 Reinforcement (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
*22.	Does spacing of reinforcement conform to ACI 318 unless otherwise stated in the construction specifications?	____	____	
*23.	Does use of bundled reinforcement conform to requirements of ACI 318 unless otherwise stated in construction specifications?	____	____	

6. INSPECTION BEFORE CONCRETING

6.2 Prestressing Tendons

	CHECK LIST	INITIALS	DATE	NOTES
*1.	Is all steel for prestressing tendons free of mud, rust, grease, insoluble oil, deposits of salt, or any other material that may adversely affect bond or durability?	____	____	
2.	Are welding operations conducted to insure that temperature of prestressing steel is not raised and that tendons are not splashed with weld material?	____	____	
3.	Do welding procedures prohibit grounding to prestressing tendons?	____	____	
*4.	Are ducts for prestressing tendons located in accordance with construction drawings?	____	____	
*5.	Are tolerances in placement of ducts for prestressing tendons in accordance with ACI 318 unless otherwise stated in the construction specifications?	____	____	
*6.	Are ducts securely fastened to prevent movement during concreting?	____	____	
*7.	Are ducts watertight with splices taped to prevent intrusion of water, grout, or concrete?	____	____	
*8.	Are ends of ducts sealed during construction to prevent entry of water?	____	____	
9.	If ducts are coated to protect against excessive rust, is a chemically neutral protective agent, such as a vapor phase inhibitor powder, employed?	____	____	
*10.	Are air vents provided at peaks in the duct profile?	____	____	

6. INSPECTION BEFORE CONCRETING

6.2 Prestressing Tendons (Continued)

CHECK LIST	INITIALS	DATE	NOTES
*11. Are drains provided at valleys of duct profile?	____	____	
*12. Are couplers used only in locations specified on construction drawings?	____	____	
*13. Are coupler housings long enough to permit necessary movements?	____	____	
*14. If flexible metal ducts are specified in special areas, are they supported by curved bearing plates to prevent local crushing?	____	____	
*15. Are ducts inspected for damage after placement of ducts, reinforcement, embedments, and forming is complete?	____	____	
*16. Are holes or openings repaired prior to concrete placement?	____	____	
*17. Are anchorages (bearing plates) located, aligned, and secured to insure that tolerances in the construction specifications will be met?			

6. INSPECTION BEFORE CONCRETING

6.3 Formwork and Embedments

	CHECK LIST	INITIALS	DATE	NOTES
*1.	Is formwork located to insure that the final structure will conform to shape, lines, dimensions, and tolerances stated in construction specifications and drawings?	____	____	
*2.	Is formwork constructed, supported, and braced in accordance with the construction specifications?	____	____	
3.	Is formwork constructed so as not to damage previously placed concrete?	____	____	
*4.	Is formwork sufficiently tight to prevent leakage of mortar?	____	____	
*5.	Are water and foreign matter being removed from interior of forms prior to concrete placement?	____	____	
*6.	Is formwork cleaned before reuse?	____	____	
*7.	Has specified release agent been applied to formwork?	____	____	
*8.	If precast concrete segments are used as forms, are placement tolerances in conformance with the construction specifications?	____	____	
*9.	If precast concrete segments are used as forms, have surfaces been prepared in accordance with construction specifications?	____	____	
*10.	Are precast concrete segments supported to prevent movement during concreting?	____	____	
*11.	Are ties and connectors between precast concrete form segments in accordance with construction specifications?	____	____	
*12.	Are construction loads monitored to insure that formwork is not accidentally overloaded?			

6. INSPECTION BEFORE CONCRETING

6.3 Formwork and Embedments (Continued)

CHECK LIST	INITIALS	DATE	NOTES
*13. Are embedded items secured in position, inspected and approved prior to concrete placement?	____	____	
*14. Are metallic embedded items and anchors electrically isolated from primary steel reinforcement in accordance with construction specifications?	____	____	
*15. Are embedded items free of oil, grease, dirt, paint, rust, deposits of salt, or any other material that may adversely affect bond or durability?	____	____	
*16. Are premolded waterstops, if specified, installed to minimize the number of joints?	____	____	
*17. Are voids in sleeves, inserts, and anchor slots protected against intrusion of concrete?	____	____	

6. INSPECTION BEFORE CONCRETING

6.4 Construction Joints

	CHECK LIST	INITIALS	DATE	NOTES
*1.	Are construction joints located as indicated in construction specifications and drawings?	____	____	
*2.	Are construction joints cleaned in accordance with construction specifications to remove laitance and unsound material, and to uniformly expose coarse aggregate?	____	____	
*3.	After cleaning, is maximum size aggregate exposed to approximately 25% of its nominal diameter?	____	____	
*4.	If specified, is epoxy-resin or other bonding compound applied in accordance with manufacturer's recommendations?	____	____	
*5.	If specified, is cement content being increased at start of the next placement?	____	____	
*6.	Are construction joints inspected after forms are placed to insure that form release agents or other foreign materials have not come into contact with the hardened concrete surface against which fresh concrete is to be placed?	____	____	

7. INSPECTION DURING CONCRETING

	CHECK LIST	INITIALS	DATE	NOTES
*1.	Are material proportions and admixtures in accordance with approved mix design?	____	____	
*2.	Is concrete transported from mixers to place of final deposit by methods that prevent segregation or loss of materials?	____	____	
3.	Is transporting equipment adequate to insure continuous supply of concrete without delays in excess of limits given in the construction specifications?	____	____	
4.	If concrete is pumped, have trials been made to insure compatibility of mix with equipment being used?	____	____	
5.	If concrete is pumped, is use of aluminum or aluminum alloy pipe prohibited?	____	____	
*6.	Is equipment for transporting and placement clean and free of foreign material?	____	____	
*7.	Are delivery tickets being completed at point of receipt of concrete?	____	____	
*8.	Are batches rejected if they do not meet slump requirements of the construction specifications?	____	____	
9.	Is there adequate control to prevent use of concrete that has contained its mixing water for a period longer than stated in the construction specifications?	____	____	
10.	Is there adequate control to prevent use of concrete that has attained initial set?	____	____	

7. INSPECTION DURING CONCRETING (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
11.	Is addition of water and remixing of concrete, if required, done under careful supervision and in accordance with the construction specifications?	____	____	
*12.	If ice or foreign materials are present in concrete, is the batch rejected?	____	____	
*13.	Are rejected batches noted on delivery ticket?	____	____	
*14.	Are required number of control test specimens being made in accordance with the construction specifications?	____	____	
*15.	Are placement temperatures of concrete within limits stated in the construction specifications?	____	____	
16.	Do the construction specifications permit concrete placement during rain, sleet, or snow?	____	____	
17.	Are procedures established to prevent rainwater from increasing mixing water or damaging the concrete surfaces?	____	____	
*18.	Is concrete deposited as near as possible to its final location?	____	____	
*19.	Is concrete deposited so as to avoid segregation or loss of materials?	____	____	
*20.	Is concrete thoroughly consolidated by vibration immediately after placement?	____	____	
*21.	Is placement of internal vibrators and spacing of external vibrators adequate to insure complete consolidation?	____	____	

7. INSPECTION DURING CONCRETING (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
*22.	Is concrete thoroughly worked around reinforcement and embedded fixtures, and into corners of forms?	____	____	
*23.	Is there any evidence of excess free water, indicating excessive bleeding, at top of lifts after concrete is consolidated?	____	____	
*24.	Are the following records being maintained:			
	(a) Delivery batch tickets?	____	____	
	(b) Daily summary report of batch plant activities?	____	____	
	(c) Daily summary report of concrete field operations?	____	____	
	(d) Records of disposition of rejected batches?	____	____	
	(e) Test results?	____	____	
	(f) Copies of batch plant recorder tapes for each batch?	____	____	
*25.	Are slump tests being performed in accordance with ASTM C143?	____	____	
*26.	Are tests for air content being performed in accordance with ASTM C231 or ASTM C173 or ASTM C138?	____	____	
*27.	Is unit weight, of normal weight concrete being measured in accordance with ASTM C138?	____	____	
28.	For lightweight concrete that must meet specified limits on air-dry unit weight, has fresh unit weight been correlated with air-dry unit weight (tested in accordance with ASTM C567) to permit use of fresh unit weight as basis for acceptance?	____	____	

7. INSPECTION DURING CONCRETING (Continued)

CHECK LIST	INITIALS	DATE	NOTES
*29. Are control test specimens being made and cured in accordance with ASTM C31?			
30. If concrete is pumped, has a correlation been established for differences in concrete properties sampled at point of delivery to pump and at point of discharge from line?			

8. INSPECTION AFTER CONCRETING

8.1 Finishing, Curing, and Formwork Removal

	CHECK LIST	INITIALS	DATE	NOTES
*1.	For decks or other flatwork, after concrete has been placed, consolidated, and screeded; are floating and troweling delayed until the surface water sheen has disappeared?	____	____	
*2.	Is freshly placed concrete maintained in a moist condition for the period stated in the construction specification?	____	____	
*3.	Do the construction specifications permit use of a heavy-duty membrane curing compound or a curing mat cover to prevent loss of moisture in lieu of continuous moist curing?	____	____	
*4.	Unless specifically permitted by the construction specifications, is seawater prohibited for curing concrete?	____	____	
*5.	In cold weather, is minimum temperature of concrete kept above the limit stated in the construction specification?	____	____	
6.	In cold weather, are precautions taken to insure that freshly placed concrete is not exposed to carbon dioxide from exhaust gases of heaters?	____	____	
*7.	In hot weather, are procedures established to keep surfaces from cracking due to rapid drying?	____	____	
*8.	Is concrete damaged by freezing rejected and replaced?	____	____	
*9.	Is concrete damaged by accelerated evaporation rejected and replaced?	____	____	

8. INSPECTION AFTER CONCRETING

8.1 Finishing, Curing, and Formwork Removal (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
10.	If accelerated curing is used for precast segments, is the curing process documented to insure strength and durability equivalent to standard moist curing?	____	____	
11.	Are forms and shores removed only after test strengths of concrete are sufficient to insure that the structure can support its own weight plus any construction loads?	____	____	
*12.	Are procedures for formwork removal such that they do not impair safety or serviceability of the structure?	____	____	
*13.	After removal of formwork, are formed surfaces finished in accordance with the construction specifications?	____	____	
*14.	After removal of formwork, are holes left from form ties filled in accordance with the construction specifications?	____	____	
*15.	If defects such as honeycombing occur, is their significance with regard to future performance evaluated prior to undertaking repair?	____	____	
*16.	If defects such as honeycombing are to be repaired, are repair procedures used in accordance with the construction specifications?	____	____	

8. INSPECTION AFTER CONCRETING

8.2 Control Tests of Hardened Concrete

CHECK LIST	INITIALS	DATE	NOTES
1. Are control test specimens being cured in accordance with ASTM C31?	____	____	
2. Are test cylinders being tested for compressive strength in accordance with ASTM C39?	____	____	
3. Are required numbers of control specimens being tested in accordance with construction specification?	____	____	
4. Are test specimens being weighed?	____	____	
5. Does structural lighweight concrete meet specified limit on air-dry unit weight as tested in accordance with ASTM C567?	____	____	
6. Are results of control tests properly documented?	____	____	
7. If splitting tensile tests are required by the construction specification, are tests being conducted in accordance with ASTM C496?	____	____	
8. Is evaluation of strength test results in accordance with the construction specification?	____	____	

8. INSPECTION AFTER CONCRETING

8.3 Post-Tensioning and Grouting

	CHECK LIST	INITIALS	DATE	NOTES
1.	Are post-tensioning operations under direction of an experienced supervisor and carried out by trained operators?	____	____	
*2.	Are tendons being stressed in sequence stated in construction specification?	____	____	
*3.	Has concrete reached specified strength prior to start of post-tensioning?	____	____	
*4.	Are components of tensioning equipment accurately set, aligned, and securely supported prior to start of tensioning?	____	____	
*5.	Are post-tensioning forces determined by measurement of tendon elongation and by measurement of jacking force?	____	____	
*6.	Is the cause for any difference of more than 5% between the two methods of measurement of post-tensioning forces determined and corrected?	____	____	
*7.	Is the total loss of prestress resulting from unreplaced broken tendon elements less than 2% of the total prestress?	____	____	
8.	Are hydraulic pressure gages for measuring jacking force calibrated against known standards (the gage and jack should be calibrated as a unit)?	____	____	
9.	If load cells are used for measuring jacking force, are they calibrated against known standards?	____	____	
*10.	Are maximum stressing force levels in conformance with the construction specification?	____	____	

8. INSPECTION AFTER CONCRETING

8.3 Post-Tensioning and Grouting (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
*11.	Are records kept for all stressing operations?	____	____	
*12.	If precast segmental construction is used, are procedures for treatment of surfaces between segments in accordance with the construction specifications?	____	____	
13.	Is grout for permanent protection of post-tensioning tendons mixed in equipment capable of continuous mechanical mixing and agitation that will produce uniform distribution of materials?	____	____	
14.	Are procedures established to insure that water is not added to increase grout flowability that has been decreased by delayed use of grout?	____	____	
15.	Is the grout screened prior to its introduction into the pump?	____	____	
16.	Is the grout pumped continuously to prevent air from being drawn into the post-tensioning duct?	____	____	
*17.	Are grout temperatures limited to less than 90F during mixing and pumping?	____	____	
*18.	Has all oil or similar material used for internal protection of the duct been removed prior to grouting (water-soluble oil may be left in ducts or on tendons)?	____	____	
19.	Are procedures for opening and closing air vents and drains established prior to start of grouting?	____	____	
20.	Is pumping pressure at tendon inlet limited to maximum specified?	____	____	

8. INSPECTION AFTER CONCRETING

8.3 Post-Tensioning and Grouting (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
21.	Do procedures for grouting long vertical tendons insure that no water is trapped at the upper end because of bleeding or other causes?	____	____	
22.	Have procedures been established, or are thixotropic admixtures being used, to prevent pockets caused by bleeding when grouting vertical or steeply inclined tendons?	____	____	
*23.	In cold weather, is grout protected from freezing?	____	____	
*24.	Are prestressing anchorages protected from exposure to seawater in accordance with the construction specification?	____	____	

9. IN-SERVICE INSPECTION

CHECK LIST	INITIALS	DATE	NOTES
1. Has vessel been surveyed within required inspection period?	____	____	
2. Have records from previous in-service inspection surveys been reviewed?	____	____	
3. Has a reference system been established to permit clear identification of inspected areas and to permit accurate designation of location of problem areas?	____	____	
4. Are data sheets and forms available for recording results of in-service condition inspection?	____	____	
5. Has marine growth or other debris been removed as required to permit inspections?	____	____	
6. With regard to damage, have exterior and interior of vessel been visually inspected for signs of:			
(a) Impact damage?	____	____	
(b) Excessive distortions?	____	____	
(c) Flexural cracking (hogging or sagging)?	____	____	
(d) Torsional cracking?	____	____	
(e) Shear cracking?	____	____	
(f) Concrete crushing?	____	____	
7. With regard to durability, have exterior and interior of vessel been visually inspected for signs of:			
(a) Cracking?	____	____	
(b) Spalling?	____	____	
(c) Scaling?	____	____	
(d) Disintegration?	____	____	

9. IN-SERVICE INSPECTION (Continued)

CHECK LIST	INITIALS	DATE	NOTES
(e) Popouts?	____	____	
(f) Erosion?	____	____	
(g) Corrosion?	____	____	
(h) Water Leakage?	____	____	
8. Have areas around prestressing tendons anchorages been inspected for signs of corrosion or deterioration?	____	____	
9. Have cathodic protection systems, if used, been inspected and serviced?	____	____	
10. Have exposed metal components and embedments been inspected for corrosion or other signs of deterioration?	____	____	
11. Have areas previously repaired been closely inspected to evaluate condition of repair?	____	____	
12. Has condition of protective coatings, if used, been inspected?	____	____	
13. Have following parts of the vessel been given special attention:			
(a) Areas subjected to alternate wetting and drying?	____	____	
(b) Areas subjected to freezing and thawing?	____	____	
(c) Areas of stress concentrations?	____	____	
(d) Areas of critical load transfer?	____	____	
(e) Areas containing construction joints?	____	____	
(f) Areas previously repaired?	____	____	

9. IN-SERVICE INSPECTION (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
14.	Are divers selected for underwater inspection qualified, experienced, trained for examination of concrete hulls, and adequately briefed on the project?	____	____	
15.	Are areas that require detailed examination and nondestructive testing clearly marked?	____	____	
16.	If areas of deterioration are suspected of affecting structural integrity of the vessel, are procedures for engineering review prior to repairs being undertaken?	____	____	

10. IN SITU TESTING OF HARDENED CONCRETE

CHECK LIST	INITIALS	DATE	NOTES
1. Have specifications for test methods and sampling plan been appraised by USCG?			
2. Is hardened concrete being examined and sampled following practices recommended in ASTM C823?			
3. For evaluation of hardened concrete under water, have accuracy and reliability of test method selected been documented?			
4. If drilled cores and sawed beams are specified for evaluating hardened concrete, are they obtained and tested in accordance with ASTM C42?			
5. Are numbers and locations of cores and beams obtained in accordance with specifications?			
6. Are test data on cores and beams available to correlate results for differences in moisture content between samples as tested and in situ concrete?			
7. Are holes left from drilled cores and sawed beams filled in accordance with specified repair procedures?			
8. Are records available for core and beam test results?			
9. If a rebound hammer is being used to evaluate hardened concrete, are rebound numbers obtained in accordance with ASTM C805?			
10. If specified, has rebound hammer been calibrated using concrete cylinders made from same concrete as in the vessel?			
11. If specified, are data available to correlate rebound numbers with core tests?			

10 IN SITU TESTING OF HARDENED CONCRETE (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
12.	If rebound numbers are correlated with core tests, are differences in moisture conditions considered?	____	____	
13.	Are numbers and locations of rebound readings in accordance with specifications?	____	____	
14.	Are records available for rebound hammer test results?	____	____	
15.	If a penetration device is being used to evaluate hardened concrete, is penetration resistance obtained in accordance with ASTM C803?	____	____	
16.	Are numbers and locations of penetration readings in accordance with specifications?	____	____	
17.	If specified, has penetration device been calibrated using concrete made with same materials?	____	____	
18.	Are holes left from penetration tests filled in accordance with specified repair procedures?	____	____	
19.	Are records available for penetration test results?	____	____	
20.	If pullout tests are specified for evaluating hardened concrete, are pullout strengths obtained in accordance with ASTM C900?	____	____	
21.	Are numbers and locations of pullout inserts in accordance with specifications (Note: Some pullout test methods must be planned prior to construction because inserts must be embedded in fresh concrete.)?	____	____	
22.	Has pullout strength been correlated with compressive strength?	____	____	
23.	Are holes left from pullout tests filled in accordance with specified repair procedures?	____	____	

10. IN SITU TESTING OF HARDENED CONCRETE (Continued)

	CHECK LIST	INITIALS	DATE	NOTES
24.	Are records available for pullout test results?			
25.	If ultrasonic pulse velocity methods are specified for evaluating hardened concrete, are pulse velocities obtained in accordance with ASTM C597?			
26.	Are numbers and locations of pulse velocity measurements in accordance with specifications?			
27.	Are records available for pulse velocity test results?			
28.	If specified for evaluating corrosion activity of reinforcing steel in concrete, are tests of half cell potentials conducted in accordance with ASTM C876?			
29.	Are numbers and locations of half cell potential measurements in accordance with specifications?			
30.	Are records available for half cell potential test results?			
31.	If specified for evaluating deteriorated concrete, are petrographic examinations of hardened concrete in accordance with practices recommended in ASTM C856?			
32.	Where applicable, are physical and chemical tests made to support petrographic examinations conducted in accordance with relevant ASTM Standards?			
33.	Are records available for results of petrographic examinations and supplementary physical and chemical tests?			
34.	If nonstandard tests are required, are they made in accordance with procedures that have been approved by the USCG?			

10. IN SITU TESTING OF HARDENED CONCRETE (Continued)

CHECK LIST	INITIALS	DATE	NOTES
35. If load tests are considered necessary to confirm safety of the vessel, are they conducted in accordance with procedures approved by the USCG?			

11. REPAIRS

CHECK LIST	INITIALS	DATE	NOTES
1. Has cause of defect been determined and have remedial measures been established to prevent recurrence?	____	____	
2. Have plans and specifications for structural repairs been approved by the USCG?	____	____	
3. Has a conference been held with USCG, Owner, ABS, Contractor, Testing Laboratory, and other interested parties to review structural repair specifications prior to start of operations?	____	____	
4. Have plans and specifications for repairs been reviewed by inspector prior to start of repair operations?	____	____	
5. Have provisions been made for documentation of repair operations?	____	____	
6. Has consideration been given to insuring that the repair method selected will not adversely affect future durability of the vessel?	____	____	
7. Have repair procedures selected been proved and documented by prior use or by tests under conditions similar to those in the vessel to be repaired?	____	____	
8. Unless otherwise specified, do cement, water, aggregates, and admixtures used for repair meet materials specifications required for new construction?	____	____	
9. Unless otherwise specified, do reinforcing materials used for repair meet materials specifications required for new construction?	____	____	
10. Do procedures for welding reinforcement during repairs conform to AWS D12.1?	____	____	

11. REPAIRS (Continued)

CHECK LIST	INITIALS	DATE	NOTES
11. If repairs are made using lap or mechanical splices of reinforcement, are splices located and made in accordance with repair specifications?	____	____	
12. Do mortar, concrete, or other repair materials have strengths, deformation characteristics, and thermal expansion characteristics that are compatible with the original concrete?	____	____	
13. As required by the particular repair condition, are organic resins or latex repair materials effective in damp, wet, and cold environments?	____	____	
14. Are organic resins or latex repair materials suitable for application to damp concrete under environmental conditions dictated by job requirements?	____	____	
15. Are manufacturer's instructions for application of repair materials strictly followed unless otherwise specified?	____	____	
16. Prior to application of repair materials, is all unsound, loose and foreign material removed?	____	____	
17. Prior to application of repair materials, is defective or deteriorated concrete completely removed to expose sound uncontaminated concrete?	____	____	
18. Is special consideration given to insure removal of all concrete that shows evidence of active or potential corrosion?	____	____	
19. Prior to application of repair materials, is exposed reinforcement thoroughly cleaned?	____	____	

11. REPAIRS (Continued)

CHECK LIST	INITIALS	DATE	NOTES
20. Are surfaces against which repair materials are to be applied free of grease, oil, or other contaminants that may affect bond?	____	____	
21. Are cracks to be repaired free of dust, oil, disintegrated material, and any debris that could affect intrusion and bond of the repair material?	____	____	
22. If cracks are repaired by epoxy injection, are procedures being used in accordance with repair specifications?	____	____	
23. For repairs using portland cement concrete, mortar, grout, or shotcrete, are curing procedures in accordance with repair specifications?	____	____	
24. Are procedures established for inspection and qualty control of underwater repairs?	____	____	
25. Are procedures established to insure safe storage and handling of volatile, flammable, or potentially toxic repair materials?	____	____	
26. Are all repair operations documented and recorded?	____	____	

APPENDIX A - APPLICABLE ASTM STANDARDS[1]

Annual Book of ASTM Standards - Part 4[2]

ASTM DESIGNATION	TITLE
A82	Standard Specification for Cold-Drawn Steel Wire for Concrete Reinforcement
A184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A185	Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
A370	Standard Methods and Definitions for Mechanical Testing of Steel Products
A416	Standard Specification for Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete
A421	Standard Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
A496	Standard Specification for Deformed Steel Wire for Concrete Reinforcement
A497	Standard Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A616	Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
A617	Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
A706	Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement

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APPENDIX A - APPLICABLE ASTM STANDARDS

Annual Book of ASTM Standards - Part 4 (continued)

ASTM DESIGNATION	TITLE
A722	Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
A767	Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement

APPENDIX A - APPLICABLE ASTM STANDARDS (1)
Annual Book of ASTM Standards - Part 10 (2)

ASTM DESIGNATION	TITLE
E328	Recommended Practice for Stress-Relaxation Tests for Materials and Structures

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APPENDIX A - APPLICABLE ASTM STANDARDS (1)
Annual Book of ASTM Standards - Part 13 (2)

ASTM DESIGNATION	TITLE
C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
C114	Standard Methods for Chemical Analysis of Hydraulic Cement
C115	Standard Test Method for Fineness of Portland Cement by the Turbidimeter
C150	Standard Specification for Portland Cement
C151	Standard Test Method for Autoclave Expansion of Portland Cement
C157	Standard Test Method for Length Change of Hardened Cement Mortar and Concrete
C183	Standard Methods of Sampling Hydraulic Cement
C185	Standard Test Method for Air Content of Hydraulic Cement Mortar
C186	Standard Test Method for Heat of Hydration of Hydraulic Cement
C187	Standard Test Method for Normal Consistency of Hydraulic Cement
C188	Standard Test Method for Density of Hydraulic Cement
C190	Standard Test Method for Tensile Strength of Hydraulic Cement Mortars
C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
C204	Standard Test Method for Fineness of Portland Cement by Air Permeability Apparatus
C219	Standard Definitions of Terms Relating to Hydraulic Cement
C265	Standard Test Method for Calcium Sulfate in Hydrated Portland Cement Mortar

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APPENDIX A - APPLICABLE ASTM STANDARDS
Annual Book of ASTM Standards - Part 13 (continued)

ASTM DESIGNATION	TITLE
C266	Standard Test Method for Time of Setting of Hydraulic Cement by Gillmore Needles
C305	Standard Method for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
C348	Standard Test Method for Flexural Strength of Hydraulic Cement Mortars
C349	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using Portions of Prisms Broken in Flexure)
C451	Standard Test Method for Early Stiffening of Portland Cement (Paste Method)
C452	Standard Test Method for Potential Expansion of Portland Cement Mortars Exposed to Sulfate
C490	Standard Specification for Apparatus for Use in Measurment of Length Change of Hardened Cement Paste, Mortar, and Concrete
C511	Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C595	Standard Specification for Blended Hydraulic Cements
C596	Standard Method of Measuring the Drying Shrinkage of Mortar Containing Portland Cement

APPENDIX A - APPLICABLE ASTM STANDARDS (1) (2)
Annual Book of ASTM Standards - Part 14

ASTM DESIGNATION	TITLE
C29	Standard Test Method for Unit Weight and Voids in Aggregate
C31	Standard Method of Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C40	Standard Test Method for Organic Impurities in Sands for Concrete
C42	Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C70	Standard Test Method for Surface Moisture in Fine Aggregate
C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C87	Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C94	Standard Specification for Ready-Mixed Concrete
C116	Standard Test Method for Compressive Strength of Concrete Using Portions of Beams Broken in Flexure
C117	Standard Test Method for Materials Finer than No. 200 (75-μm) Sieve in Mineral Aggregates by Washing
C123	Standard Test Method for Lightweight Pieces in Aggregate
C125	Standard Definitions of Terms Relating to Concrete and Concrete Aggregates
C127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
C128	Standard Test Method for Specific Gravity and Absorption of Fine Aggregate

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APPENDIX A - APPLICABLE ASTM STANDARDS
Annual Book of ASTM Standards - Part 14 (continued)

ASTM DESIGNATION	TITLE
C131	Standard Test Method for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
C138	Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
C143	Standard Test Method for Slump of Portland Cement Concrete
C144	Standard Specifications for Aggregate for Masonry Mortar
C156	Standard Test Method for Water Retention by Concrete Curing Materials
C171	Standard Specification for Sheet Materials for Curing Concrete
C172	Standard Method of Sampling Fresh Concrete
C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C174	Standard Method of Measuring Length of Drilled Concrete Cores
C192	Standard Method of Making and Curing Concrete Test Specimens in the Laboratory
C215	Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Frequencies of Concrete Specimens
C227	Standard Test Method for Potential Alkali Reactivity of Cement - Aggregate Combinations (Mortar-Bar Method)
C230	Standard Specification for Flow Table for Use in Tests of Hydraulic Cement
C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C232	Standard Test Method for Bleeding of Concrete
C233	Standard Method of Testing Air-Entraining Admixtures for Concrete

APPENDIX A - APPLICABLE ASTM STANDARDS
Annual Book of ASTM Standards - Part 14 (continued)

ASTM DESIGNATION	TITLE
C235	Standard Test Method for Scratch Hardness of Coarse Aggregate Particles
C260	Standard Specification for Air-Entraining Admixtures for Concrete
C289	Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
C293	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
C294	Standard Descriptive Nomenclature of Constituents of Natural Mineral Aggregates
C295	Standard Recommended Practice for Petrographic Examination of Aggregates for Concrete
C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C311	Standard Methods of Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
C330	Standard Specification for Lightweight Aggregates for Structural Concrete
C341	Standard Test Method for Length Change of Drilled or Sawed Specimens of Cement Mortar and Concrete
C342	Standard Test Method for Potential Volume Change of Cement-Aggregate Combinations
C387	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
C403	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
C418	Standard Test Method for Abrasion Resistance of Concrete by Sandblasting
C441	Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction

ASTM DESIGNATION	TITLE
C457	Standard Recommended Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete
C469	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
C470	Standard Specification for Molds for Forming Concrete Test Cylinders Vertically
C494	Standard Specification for Chemical Admixtures for Concrete
C496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
C512	Standard Test Method for Creep of Concrete in Compression
C535	Standard Test Method for Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine
C566	Standard Test Method for Total Moisture Content of Aggregate by Drying
C567	Standard Test Method for Unit Weight of Structural Light-Weight Concrete
C586	Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)
C597	Standard Test Method for Pulse Velocity Through Concrete
C617	Standard Method of Capping Cylindrical Concrete Specimens
C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C642	Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete
C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
C671	Standard Test Method for Critical Dilation of Concrete Specimens Subjected to Freezing
C672	Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals

Annual Book of ASTM Standards - Part 14 (continued)

ASTM DESIGNATION	TITLE
C682	Standard Recommended Practice for Evaluation of Frost Resistance of Coarse Aggregates in Air-Entrained Concrete by Critical Dilation Procedures
C683	Standard Test Method for Compressive and Flexural Strength of Concrete Under Field Conditions
C684	Standard Method of Making, Accelerated Curing, and Testing of Concrete Compression Test Specimens
C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
C702	Standard Methods for Reducing Field Samples of Aggregate to Testing Size
C803	Tenative Test Method for Penetration Resistance of Hardened Concrete
C805	Standard Test Method for Rebound Number of Hardened Concrete
C823	Standard Recommended Practice for Examination and Sampling of Hardened Concrete in Constructions
C827	Standard Test Method for Early Volume Change of Cementitious Mixtures
C851	Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
C856	Standard Recommended Practice for Petrographic Examination of Hardened Concrete
C873	Tentative Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
C876	Standard Test Method for Half Cell Potentials of Reinforcing Steel in Concrete
C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete
C883	Standard Test Method for Effective Shrinkage of Epoxy-Resin Systems Used With Concrete

APPENDIX A - APPLICABLE ASTM STANDARDS

Annual Book of ASTM Standards - Part 14 (continued)

ASTM DESIGNATION	TITLE
C884	Standard Test Method for Thermal Compatibility Between Concrete and An Apoxy-Resin Overlay
C900	Tentative Test Method for Pullout Strength of Hardened Concrete
D75	Standard Methods of Sampling Aggregates
D1411	Standard Test Methods for Water-Soluble Chlorides Present as Admixes in Graded Aggregate Road Mixes
E4	Standard Methods of Load Verification of Testing Machines
E11	Standard Specification for Wire-Cloth Sieves for Testing Purposes
E12	Standard Definitions of Terms Relating to Density and Specific Gravity of Solids, Liquids, and Gases
E329	Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
-	Manual of Aggregate and Concrete Testing

APPENDIX A - APPLICABLE ASTM STANDARDS (1)
Annual Book of ASTM Standards - Part 15 (2)

ASTM DESIGNATION	TITLE
D3398	Standard Test Method for Index of Aggregate Particle Shape and Texture

(1) American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103

(2) Use latest edition

APPENDIX A - APPLICABLE ASTM STANDARDS (1)
Annual Book of ASTM Standards - Part 31 (2)

ASTM DESIGNATION	TITLE
D152	Standard Test Methods for Chloride Ion in Water and Waste Water
D516	Standard Test Methods for Sulfate Ion in Water and Waste Water
D1888	Standard Test Method for Particulate and Dissolved Matter, Solids, or Residue in Water

(1) American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103

(2) Use latest edition

APPENDIX B - STANDARDS, GUIDES, AND RECOMMENDED PRACTICES OF THE AMERICAN CONCRETE INSTITUTE[1]

ACI COMMITEE[2]	TITLE
116	- Cement and Concrete Terminology
201	- Guide to Durable Concrete
201	- Guide for Making a Condition Survey of Concrete in Service
211	- Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete
211	- Recommended Practice for Selecting Proportions for Structural Lightweight Concrete
212	- Guide for Use of Admixtures in Concrete
212	- Admixtures for Concrete
213	- Guide for Structural Lightweight Aggregate Concrete
214	- Recommended Practice for Evaluation of Strength Test Results of Concrete
221	- Selection and Use of Aggregates for Concrete
301	- Specifications for Structural Concrete for Buildings
304	- Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
304	- Preplaced Aggregate Concrete for Structural and Mass Concrete
304	- Placing Concrete by Pumping Methods
304	- Placing Concrete With Belt Conveyors
305	- Hot Weather Concreting
306	- Cold Weather Concreting
308	- Recommended Practice for Curing Concrete
309	- Recommended Practice for Consolidation of Concrete

(1) American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, Michigan 48219.
(2) See latest edition of ACI Manual of Concrete Practice.

APPENDIX B - STANDARDS, GUIDES, AND RECOMMENDED PRACTICES OF THE AMERICAN CONCRETE INSTITUTE (Continued)

ACI COMMITTEE	TITLE
311	- Recommended Practice for Concrete Inspection
311	- ACI Manual of Concrete Inspection
315	- Manual of Standard Practice for Detailing Reinforced Concrete Structures
318	- Building Code Requirements for Reinforced Concrete
318	- Commentary on Building Code Requirements for Reinforced Concrete
347	- Recommended Practice for Concrete Formwork
347	- Precast Concrete Units Used as Forms for Cast-in-Place Concrete
357	- Guide for the Design and Construction of Fixed Offshore Concrete Structures
503	- Use of Epoxy Compounds With Concrete
503	- Standard Specification for Bonding Hardened Concrete, Steel, Wood, Brick, and Other Materials to Hardened Concrete With a Multi-Component Epoxy Adhesive
503	- Standard Specification for Bonding Plastic Concrete to Hardered Concrete With a Multi-Component Epoxy Adhesive
503	- Standard Specification for Repairing Concrete With Epoxy Mortars
504	- Guide to Joint Sealants for Concrete Structures
506	- Recommended Practice for Shotcreting
506	- Specification for Materials, Proportioning, and Application of Shotcrete
515	- Guide for the Protection of Concrete Against Chemical Attack by Means of Coatings and Other Corrosion-Resistant Materials
517	- Recommended Practice for Atmospheric Pressure Steam Curing of Concrete

APPENDIX B - STANDARDS, GUIDES, AND RECOMMENDED PRACTICES

OF THE AMERICAN CONCRETE INSTITUTE (Continued)

ACI COMMITTEE	TITLE
533	- Selection and Use of Materials for Precast Concrete Wall Panels
534	- Fabrication, Handling, and Erection of Precast Concrete Wall Panels
546	- Guide for Repair of Concrete Bridge Superstructures

APPENDIX C - OTHER APPLICABLE STANDARDS, GUIDES AND RECOMMENDED PRACTICES

1. "Rules for the Design, Construction, and Inspection of Offshore Structures," Det Norske Veritas, Oslo, 1977.

2. "Guidelines for the Design, Construction, and Classification of Floating Concrete Structures," Det Norske Veritas, Oslo, 1978.

3. "Recommendations for the Design and Construction of Concrete Sea Structures," Federation Internationale de la Precontrainte, Wexham Springs, 1977.

4. Allen, R.T.L. and Gregory-Cullen, J., "Inspection, Maintenance, and Repair of Concrete Offshore Structures," RR SMT-7401, Cement and Concrete Association, London, 1974.

5. "Design and Control of Concrete Mixtures," 12th Edition, Portland Cement Association, Skokie, Illinois, 1979, 133 pp.

6. "Certification of Ready Mixed Concrete Production Facilities," National Ready Mixed Concrete Association, Silver Spring, Maryland, 1976.

7. "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau," Truck Mixer Manufacturers Bureau, Silver Spring, Maryland, 1971.

8. "Manual of Standard Practice," Concrete Reinforcing Steel Institute, Chicago, 1976.

9. "Manual of Standard Practice - Welded Wire Fabric," Wire Reinforcement Institute, Inc., McLean, Virginia, 1979.

10. "Reinforcing Steel Welding Code," American Welding Society, AWS D12.1-75, Miami, Florida, 1975.

11. "PTI Post-Tensioning Manual," Post-Tensioning Institute, Phoenix, Arizona, 1981.

APPENDIX D - ABBREVIATIONS

ABS	=	American Bureau of Shipping
ACI	=	American Concrete Institute
ASTM	=	American Society for Testing and Materials
AWS	=	American Welding Society
DNV	=	Det Norske Veritas
FIP	=	Federation Internationale de la Precontrainte
NRMCA	=	National Ready Mixed Concrete Association
PCA	=	Portland Cement Association
PTI	=	Post-Tensioning Institute
TMMB	=	Truck Mixer Manufacturers Bureau